DOCUMENT RESUME

ED 060 491 CG 007 112

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TITLE An Assessment of the Feeling-of-Knowing and Factors Influencing Its Accuracy.
INSTITUTION Bucknell Univ., Lewisburg, Pa.
PUB DATE 71
NOTE 18p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Memory; *Perception; *Recall (Psychological); *Recognition; *Sex Differences

ABSTRACT

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AN ASSESSMENT OF THE FEELING-OF-KNOWING AND FACTORS INFLUENCING ITS ACCURACY

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Abstract

The accuracy of the feeling of knowing (FOK) was assessed with regard to recall and recognition under three conditions: advanced or no advanced organizers; learned or non-learned information; and, sex differences. Twenty subjects learned paired-associates and were tested for recall and recognition accompanied by ratings of FOK strength. The feeling-of-not-knowing was more accurate for females under the non-learned condition.

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The learner often experiences the situation in which he feels that he knows the correct response to a question even though he is unable, at the moment, to retrieve the necessary information from memory to provide an answer. The feeling accompanying the experience is referred to frequently as the feeling-of-knowing (FOK). The FOK is experienced countless times as the human learner struggles to retrieve information stored daily in his memory system and has become the topic of recent research in information processing. Awareness of the accuracy of such feelings is important to the learning process since the degree to which the learner feels he knows a designated body of knowledge may determine to a great extent whether he makes further efforts to learn. The general purpose of the present research was to determine the accuracy of feelings of knowing and not knowing, and to identify variables which may influence the accuracy.

The role that the FOK plays in information processing has been the subject of recent research by Hart (1965, 1966, 1967a, 1967b) who sought to determine the accuracy of the FOK. To establish conditions in which the FOK is experienced, Hart asked his subjects to answer general information questions (or to supply the response words in a paired-associate task); to give to each answer a rating of how strongly they felt they could recognize the correct answer even

if they had been unable to recall it; and, finally, to attempt to recognize the correct answers to the same questions presented in multiple choice form. To determine the accuracy of the FOK, Ss' performance on the multiple choice questions was compared to their predicted ability to correctly recognize answers. More specifically, feeling-of-knowing hits (FK) were compared to feeling-of-not knowing misses ($\overline{FK}$). A FK hit was scored when an S felt that he could correctly recognize an answer and then in fact did correctly recognize it. A $\overline{FK}$ miss was scored when a subject rated a question as being one that he would not be able to correctly recognize, but then did correctly recognize. Hart's analysis was thus based on those items which were correctly answered on the recognition test. FK misses and $\overline{FK}$ hits were not included in the assessment of the FOK since they represented items which the Ss had missed on the recognition test. Hart found significantly greater proportions of FK hits than $\overline{FK}$ misses. He concluded that the FOK is a "relatively accurate" indicator of what has been stored in memory. His assessment of the FOK was, however, limited in the sense that only FK hits were compared to $\overline{FK}$ misses. Thus, the accuracy of the FK was relative only to the inaccuracy of the $\overline{FK}$. Also, because the storage of information was not controlled, Hart had no way of knowing if the items missed on the recognition test were the result of an inaccuracy of the $\overline{FK}$. Also, because the storage of information was not controlled, Hart had no way of knowing if the items missed on the recognition test were the result of an inaccuracy in the Ss' retrieval process or the result of a lack of information storage.

The same problems occurred in two other studies which used Hart's methods of analysis. Freedman and Laudauer (1966) found that Ss correctly recognized 73% of the items they felt they knew, and were able to recognize 35% of the items they did not know. Hauck and Isakson (1971) also found significant

differences between proportions of FK hits (.55) and $\overline{FK}$ misses (.29) using general information questions.

A specific purpose of the present study was to overcome some of the problems of previous research by controlling the storage of information so that direct comparisons could be made of the FOK on stored and non-stored information. Also, by controlling the degree of information storage, it is possible to assess the accuracy of the feeling-of-not-knowing ($\overline{FK}$). If Ss can discriminate between learned and non-learned information and give $\overline{FK}$ ratings to the non-learned information, then the $\overline{FK}$ is accurate. Such a measure of the $\overline{FK}$ was not possible in previous studies. The $\overline{FK}$ is important to the efficiency of learning because if a person is not accurate in determining when information has not been stored in memory, he may waste a great amount of time trying to retrieve knowledge that was never stored.

The accuracy of the FOK after recognition, or the accuracy of the confidence placed by a learner in a recognition has not been examined. The accuracy of this second kind of FOK judgement is important to establish because the FOK judgement after recognition could determine whether or not a learner retains his responses or reconsiders and chooses others. A second purpose of the present research was to establish the accuracy of the FOK after recognition.

Previous studies have not dealt with variables which may influence the accuracy of the FOK. Although it has been established that retrieval of information can be enhanced through the use of categorization or advanced organization of information being learned (Ausubel, 1960; Mandler, 1967; Miller, 1956, 1967), no research relates the FOK to organization. A third and final purpose of the present study was to determine if organization of information and sex differences influence the accuracy of the FOK.

In summary, the present research attempted to answer the following four-part question. How accurate is the FOK with regard to: (a) the degree of information storage; (b) recognition; (c) advanced organization of information; and, (d) sex differences?

Method

Design

The general design of the experiment consisted of the recall-judgement-recognition paradigm employed by Hart, plus a second judgement by Ss after a recognition attempt. Various factorial designs were used with several dependent variables to test the effects of degree of information storage, sex, and mode of information storage (advanced organizers) on FOK accuracy. Each design is indicated with the results of each analysis.

Subjects

Ten adult males and 10 adult females of varying professional and education backgrounds with ages ranging from 20 to 45 years were randomly assigned to two treatment groups: advanced organizers and non-advanced organizers. The Ss were stratified according to sex with five males and five females in each group.

Materials

The materials consisted of: (a) paired-associates memorized by each S; (b) three tests, one pretest of ability to memorize paired-associates, and two posttests, one for recall and one for recognition of learned paired-associates; and, (c) Likert type scales on which each S rated his feeling-of-knowing to items on the posttests.

The pretest was constructed from 20 randomly paired words, chosen for their high frequency of occurrence (at least 50 per million) as indicated by by the Thorndike-Lorge (1944) word count. Each item of the pretest was written

on a 3 X 5 card and consisted of the stimulus word of a word pair. Knowledge of results was presented for each item on a 3 X 5 card, also.

Each of the two posttests consisted of 50 paired-associate items made up of stimulus words of a word pair which could be placed into one of five categories. In each category the stimulus word was linked to its response by a rule or concept. The concepts which served as labels for the five categories and an example of a word pair for each category are:

1. Covers: the stimulus covers the response.
   Example: Tent - Cake
2. Supports: the stimulus supports the response.
   Example: Table - Key
3. Around: the stimulus goes around the response.
   Example: Chain - Boot
4. Smashes: the stimulus smashes the response.
   Example: Brick - Gourd
5. Into: the stimulus goes into the response.
   Example: Tire - Box.

Ten paired-associates were grouped under each category. Five pairs in each category were randomly selected for Ss to memorize. Thus when Ss responded to the posttests, 25 pairs of the 50 items had been memorized and the other 25 fictitious. The arrangement of memorized and fictitious items permitted the examination of responses to information which had been either stored or not stored, and the five categories permitted the study of advanced organizers.

Each posttest consisted of the same paired-associate words. The posttest of recall required the responder to supply the missing response word. The recognition test was multiple choice with four possible choices for answers. The three distractors chosen for each item were logical responses with respect

to the category of the correct choice.

The Ss made their recall and recognition responses on answer sheets which were provided. A scale on which Ss could rate for FOK appeared adjacent to each item. The Ss rated their FOK on the following scale:

YES			NO		
6	5	4	3	2	1

The following key to the FOK scale appeared at the top of each page of the answer sheets:

6	5	4	3	2	1
Definitely Know	Fairly confident of knowing	Slightly certain of knowing	Slightly certain of not knowing	Fairly confident of not knowing	Definitely do not know

Procedure

In the first phase of the experiment, the pretest of paired-associate learning ability was administered individually to the Ss. The 10 PA's were first presented one at a time on 3 X 5 cards for approximately three seconds each. After the initial exposure each stimulus word was presented and Ss attempted to verbally supply the response word. Knowledge of results was given after each attempt. In the event of an incorrect response, S was allowed to see the entire PA again for three seconds. The pretest was completed as soon as S could go through all 10 pairs without making any errors. The number of trials each S needed to reach the criterion was recorded and this measure was used as a covariate in the analysis of covariance which was performed to test several of the hypotheses of the study.

One week after the pretest was administered, training began on another group of PA's on which Ss' FOK and retention were to be tested. The Ss in the advanced organizer group (Treatment I) were instructed that they were to learn 25 PA's which had been grouped into five categories with five PA's per category.

A sample pair, CAR - GARAGE, from the category "Into" was shown to the Ss. They were instructed to think of the category concepts as they were shown the PA's during an initial exposure. The concept for each category was explained before exposure to the PA's in the category began. When the instructions had been given, exposure to the PA's began. At the beginning of each category, an example of a PA fitting in the category was presented. Then, Ss were allowed to see each PA in the category for three seconds. Subjects were exposed to and trained on one category at a time.

The initial exposure for the non-advanced organizer group (Treatment II) was the same as that for Treatment I except Ss in the Treatment II were told nothing about the categorization of the PA's. Each S was shown the sample pair, CAR - GARAGE, but was not given any directions as to how to go about learning the PA's.

The order of presentation of the PA's within categories was the same for Ss in both treatment groups. Immediately following the initial exposure of the PA's within a category, the training trials were begun. The S saw a stimulus word and tried to supply the response word. After the attempt, S saw a card bearing both words of the PA, not one of the original five PA's of the category, was inserted. The inserted pair fit logically into the category of the replaced PA, but in no way entered into any subsequent test or analysis. They served the purpose of eliminating repetition of already learned pairs while maintaining a constant number of pairs which Ss were trying to learn at any one time. The order of the PA's within a category was varied over the learning trials. When Ss gave the correct response for each of the original five stimulus words in a category, training ceased on that category and another was begun. The training continued until each S came to a 100% criterion on each of the five categories.

One week following training, Ss were tested individually on their recall

and recognition of the 25 PA's they had learned during the training one week earlier. They were also tested on the 25 non-learned PA's. After the presentation of each stimulus word, S attempted to recall the word that had been paired with it and to write that word on the answer sheet. For each PA presented S made a FOK judgement based on how strongly he felt that he knew the response word and would be able to recognize it in the form of a multiple choice question. The S rated his FOK on the six-point scale. This rating following an attempt at recall constituted FOK Rating 1. The 50 PA's were presented to S for recall and Rating 1 and then the recognition test began. No knowledge of results on the recall test was given. The stimulus words were again presented, but this time they were accompanied by four possible response words. The Ss chose the word they felt the stimulus word had been paired with and recorded their answer. After each recognition attempt, Ss rated their FOK on the basis of how strongly they felt the word they had chosen was the correct response word. Once again this rating, FOK Rating 2, was made on the six-point scale provided on the answer sheet. The experiment was completed when all 20 Ss had been individually tested for recall and recognition and had given their FOK judgements on Ratings 1 and 2.

Results

The mean proportions of FK and $\overline{FK}$ hits and misses for both FOK ratings, after recall and after recognition, on the combined learned and non-learned pairs approximate most closely the data obtained in the studies by Hart (1965, 1966, 1967a, 1967b) where degree of information storage was not controlled. In comparing proportions of FK hits to $\overline{FK}$ misses on Rating 1 (after recall), there was no significant difference found between the two proportions (.66 for FK hits and .41 for $\overline{FK}$ misses; $t = 1.58$, $p > .05$, two-tailed). On Rating 2, which came after the recognition attempt, there was a significant difference found between

proportions of FK hits (.74) and FK misses (.30) ($t = 3.31$, $p<.01$). Thus for the combined learned and non-learned PA's the findings of Hart were replicated only on the rating following recognition.

In comparing proportions of FK hits (.79) to FK misses (.65), it was found that there was no significant difference for Rating 1 ($t = 1.04$, $p>.05$, two-tailed). On Rating 2, however, there were significantly more FK hits (.87) than $\overline{FK}$ misses (.36), ($t = 3.45$, $p<.01$, two-tailed). Once again, as with the combined PA's, the FOK judgements were accurate, as accuracy is defined by Hart, only on the rating following recognition and not on the recall rating on which Hart had found FOK accuracy.

When both types of hits (FK and $\overline{FK}$) were combined and compared to misses (FK and $\overline{FK}$) on the 25 learned pairs there was no significant difference between Overall hits (.61) and Overall misses (.39) on Rating 1 ($t = 1.00$, $p>.05$, two-tailed). On Rating 2 there was a significant difference between proportions of Overall hits (.83) and Overall misses (.17), ($t = 3.95$, $p<.05$, two tailed).

The question of whether the factors, degree of information storage (learned or non-learned), sex of learner, and mode of information storage (advanced and no advanced organizers), have any effects on the accuracy of the FOK was tested with the ANCOVA for Ratings 1 and 2 using four different dependent variables: Overall hits, $\overline{FK}$ hits, FK hits, and $\overline{FK}$ ratings. In all of the ANCOVA's, trials to criterion on the pretest served as the covariate.

For Overall hits on Rating 1, a three-way ANCOVA for repeated measures with sex, mode of storage, and degree of storage as dependent variables showed no significant effects or interactions among the variables. On Rating 2 there was a significant effect from degree of storage ($F = 33.95$, $p<.01$) with more Overall hits achieved on the learned than on the non-learned PA's. There were no other significant differences or interactions with Overall hits on Rating 2 as the

dependent variable.

With $\overline{FK}$ hits as the dependent variable, the effects of sex, mode of storage and degree of storage on FOK accuracy were tested. On Rating 1 a three-way ANOVA indicated a significant effect from degree of storage with more $\overline{FK}$ hits achieved on the non-learned PA's ($F = 55.68$, $p<.01$). The factors of sex and mode of information storage had no significant effects on $\overline{FK}$ hits on Rating 1.

For $\overline{FK}$ hits on Rating 2, the ANCOVA showed significant effects resulting from the factors of mode of storage ($F = 5.40$, $p<.05$) and degree of storage ($F = 169.00$, $p<.001$). The Ss in the non-advanced organizer group achieved more $\overline{FK}$ hits than did Ss in the advanced organizer group. With regard to degree of storage, the non-learned PA's produced more $\overline{FK}$ hits than did the learned PA's as was the case for Rating 1. The factor of sex of learner had no effect on the dependent variable. There was, however, a significant interaction ($F = 4.84$, $p<.05$) between sexes with regard to the non-learned PA's. Females scored more $\overline{FK}$ hits than did males.

A two-way ANCOVA with FK hits on the 25 learned PA's as the dependent variable and sex and mode of storage as independent variables showed no significant effects or interactions on either Rating 1 or Rating 2.

A two-way ANCOVA with $\overline{FK}$ ratings on the 25 non-learned PA's as the dependent variable and sex and mode of storage as independent variables showed no significant effects or interactions on either Rating 1 or Rating 2.

To determine if the advanced organizers used in the experiment had a beneficial effect on Ss' recognition performance, a two-way ANCOVA was performed with correct recognition responses as the dependent variable and sex and mode of information storage as independent variables. A significant effect was produced by the mode of storage factor with Ss in the advanced organizer group correctly recognizing more of the PA's than Ss in the non-advanced organizer group ($F = 7.64$, $p<.05$).

Discussion

The results of this study contribute to the information concerning the accuracy of the feeling-of-knowing and the effects that certain factors have on the ability to accurately assess what information one has or has not stored in memory.

In general, the results obtained by Hart (1965, 1966, 1967a, 1967b) in studying the FOK were not replicated. That is, in arriving at a measure of FOK accuracy, the proportions of FK hits were not significantly greater than the proportions of $\overline{FK}$ misses for the FOK rating following recall. The FK and $\overline{FK}$ hit and miss proportions on the 25 learned and the 25 non-learned PA's were combined in the present study to approximate the situation created by Hart where degree of information storage was not controlled. The FK hit (.66) and $\overline{FK}$ miss (.41) proportions for Rating 1 were almost identical to those reported by the Hart (1967a) experiment. Statistically, the non-significance could arise only if the within-group variance for the present study were greater than that for Hart's study. Thus the most plausible explanation for the result lies in the difference between populations studied in Hart's experiment and the present experiment. In the present study, adults who exhibited a wide range of educational and intellectual differences served as Ss; however, Hart used college undergraduates who probably formed a more homogeneous sample with respect to learning variables. Support for the explanation is found in the Hauck and Isakson (1971) experiment in which Hart's findings were replicated when college students were used as Ss. The identification within each population, college student and non-student adults, of the exact variables which lead to a difference in information processing were not identified.

The FOK rating after recall, Rating 1, did not yield accurate judgements when FK hits and $\overline{FK}$ misses were compared for only the 25 learned PA's. Also when Overall (FK and $\overline{FK}$) hits were compared to Overall misses on the learned PA's there were not significantly more hits than misses. It can, therefore, be concluded that the FOK is not accurate among adult, non-student Ss for the FOK rating following recall.

The FOK rating following recognition was found to be more accurate than the recall rating. What is it about FOK Rating 1 that brings about lower FK hits proportion and higher $\overline{FK}$ miss proportions than is seen on Rating 2? Aside from the fact that the added informational input from the multiple choice questions makes Rating 2 somewhat less difficult, are there any other factors which might contribute to differences of accuracy? A possible explanation lies in the notion of response bias. Underwood (1966) states: "The fact is that we have response biases of a wide variety, and whenever we must make a decision in an ambiguous situation, these biases are likely to be involved in the decision. Even if the S is responding with 'yes' or 'no' and has to make a decision on an ambiguous threshold-measurement trial, we may find him saying 'yes' more than 'no'" [pp. 186-187]. On the other hand, we may find the S biased toward "no" more than "yes" and this is what appears to have happened in the present study. The Ss were observed to be worried about rating PA's, FK, and then not being able to recognize them correctly. Indeed, one S did not give a FK rating to a single PA from among the 25 he had learned the week before. Yet on the recognition test his performance was above average. This "better to be safe than sorry" bias in making FOK ratings after recall caused many of the learned PA's to be rated $\overline{FK}$. On the average, 9.3 of the learned PA's were rated $\overline{FK}$ on Rating 1. These items resulted in $\overline{FK}$ misses when they were subsequently recognized correctly. The response bias was not as strong on Rating 2 where $\overline{FK}$ ratings

on learned PA's averaged only 5.1. The underlying reason for the response bias toward hesitancy in giving FK ratings is a personality variable which remains to be explored.

The results of the present study shed some light on the question of what factors influence the accuracy of the FOK. Degree of information storage was found to have the effect that would be expected. The Ss achieved significantly more Overall hits than misses on Rating 2 on the learned PA's. In general it would seem that Ss are able to make more accurate judgements about information that has been stored in memory than about information that has not been stored. The nature of the recognition task, however, may have led to a response bias where Ss rated many of the non-learned PA's FK simply because of the confidence they felt from recognizing the learned PA's and giving them FK ratings. The fact that there were no differences in number of Overall hits between learned and non-learned PA's on Rating 1 would tend to support the explanation of a response bias. On Rating 1 the recall task was sufficiently difficult so that Ss did not feel overly confident in their ability to correctly recognize the response words. In fact, the bias seemed to be toward being too cautious in giving FK ratings.

The factor, degree of storage, also affected the number of $\overline{FK}$ hits. More $\overline{FK}$ hits were achieved on the non-learned PA's than on the learned PA's. This result was expected since Ss rated significantly more of the non-learned pairs $\overline{FK}$ than FK. The fact that these $\overline{FK}$ ratings on the non-learned PA's resulted in $\overline{FK}$ hits is natural since the Ss were expected not to correctly recognize the response words for non-learned PA's. Degree of storage, then, was found to indicate that Ss were generally able to discriminate between the learned and non-learned information.

The factor, sex of learner, had no effect on FOK accuracy except in the

instance of $\overline{FK}$ hits on Rating 2 where it was found that female Ss scored more $\overline{FK}$ hits on the non-learned PA's than did males. An explanation of this result must await further research into sex differences, perhaps in the area of differential response styles.

It is of interest to note that the factor, mode of information storage, had little or no effect on FOK accuracy especially in light of the fact that the advanced organizers were found to facilitate correct recognition of the response words. The only instance where mode of storage influenced FOK accuracy was in the achieving of $\overline{FK}$ hits on Rating 2 where Ss in the non-advanced organizer group out-performed Ss who had been trained with advanced organizers. This effect could be partially due to Ss in the advanced organizer group rating fewer items $\overline{FK}$ than did Ss in the non-advanced organizer group. Thus, the advanced organizer group got fewer $\overline{FK}$ hits because they were able to correctly recognize more of the PA's than did the Ss using no advanced organizers. Fewer $\overline{FK}$ ratings and more correct recognitions would then cause the Ss using advanced organizers to achieve fewer $\overline{FK}$ hits. If advanced organizers facilitate recognition performance, as they were found to do, why is the FOK accuracy not facilitated correspondingly? Subjects possibly do not realize that advanced organizers can have a facilitative effect on recognition and thus they respond as if no advanced organization were present. A descrepancy between FOK judgement and recognition performance could result and the FOK accuracy decrease.

When the accuracy level of the FOK has been firmly established, the FOK rating could be used in studies of human learning to determine what the learner has stored in memory even though the information may not be accessible to immediate retrieval. If the human learner had a retrieval system that allowed him to determine exactly what had been stored in memory and to bring that information to a conscious awareness, there would be no need to study the FOK. This, however,

is not the case. Since the accurate retrieval of information plays a vital role in the student's success in school, the research done to find ways of improving the efficiency of assessing what information has or has not been stored in memory has direct application in the educational process.

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